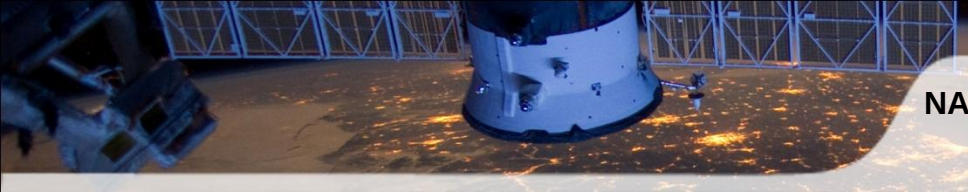


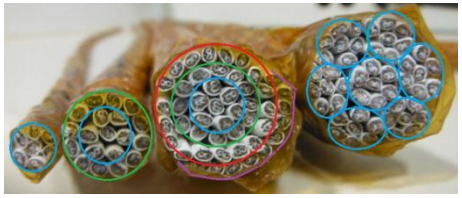
NASA SPACE TECHNOLOGY RESEARCH FELLOWSHIP
Grant NNX11AM61H

GOAL / EXPECTED OUTCOMES

- Significant progress on methods of describing structural cable effects and models to predict damped response of cabled beams
- A database of experimental results characterizing the dynamics response of cable-harnessed structures to vibration input, as well as the effects of bakeout on space flight cables
- Understanding of the factors involved in cable modeling, development of applicable cable model to predict natural frequencies a priori, and publication of the results

TECHNICAL APPROACH

- Preliminary Modeling: DTFM and Rayleigh Ritz methods used to model cables as undamped Euler Bernoulli beams (oversimplified)
- Preliminary Experiments: Cable and cabled beam frequency response studied at Virginia Tech to initially categorize system behavior
- Modeling: DTFM model extended for multi-section cable modeling, necessary shear effects and damping added, and GHM damping methods incorporated (hysteretic damping)
- Experiments: Space flight cables of different sizes and geometric configurations are tested both before and after bakeout; these results are both used to characterize spaceflight cables and validate developed models



RELEVANCE TO NASA

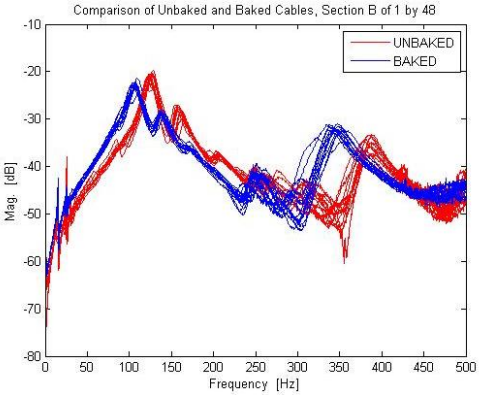
- Vibration of cabled space structures can be quantified, which will eliminate costly redesign caused by modal test results being changed due to the presence of cables added to the structure after testing
- Research will improve control systems, eliminate additional damping, and predict resonant frequencies more accurately
- Effects of bakeout on spaceflight cables will be quantified and published

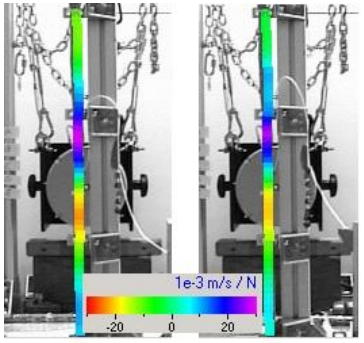
TITLE: Modeling Cable-Harness Effects on Spacecraft Structures

FELLOW	Kaitlin Spak
PRINCIPAL INVESTIGATOR	Dr. Daniel Inman, University of Michigan
UNIVERSITY	Virginia Tech
DEGREE PROGRAM	PhD, Mechanical Engineering
NSTRF YEAR (e.g., 1 of 4)	2
MENTOR (include Center)	Dr. Gregory Agnes, JPL

MAJOR ACCOMPLISHMENTS (TO-DATE)

- Preliminary testing completed and standard run developed to ensure repeatability for all future cable testing
- New spaceflight cables acquired in 1X7, 1X19, 1X48 and 7X7 configurations, tested thoroughly before bakeout
- Cables baked out and retested, results conclusive; bakeout decreases natural frequency values by about 14% for single strand cables, more than 20% for multi-strand cable, and increases damping for all cables
- Single-section Euler-Bernoulli model completed
- Presented damping research at IMAC, standard run research at SDM, bakeout effects research at IMAC, overall project progress at VSGC
- Passed Preliminary Examination for PhD degree
- Prepared draft of bakeout effects paper to submit to journal in July 2013





PLEASE LIST ALL CONFERENCES, WORKSHOPS, AND EVENTS WHERE YOU WERE A PRESENTER

Conference, Workshop, or Event Name	Location	Date	Presentation Title	Presenter(s)
International Modal Analysis Conference	Garden Grove, CA	02/12/2013	Comparison of Damping Models for Space Flight Cables	Kaitlin Spak
54th AIAA Structures, Structural Dynamics, and Materials Conference	Boston, MA	04/11/2013	Toward Modeling of Cable Harnessed Structures: Cable Damping Experiments	Kaitlin Spak
Virginia Space Grant Consortium Student Research Conference	Norfolk, VA	04/18/2013	Space Flight Cable Model Development	Kaitlin Spak
Society for Experimental Mechanics Conference	Lombard, IL	06/03/2013	Effect of Bakeout on Space Flight Cable Stiffness	Kaitlin Spak

PLEASE LIST ALL PUBLICATIONS

Publication Type (e.g., journal, book, chapter, dissertation)	Authors (list up to first six)	Year Published	Publication Title	Journal or Book Name	Journal Volume, Issue, Page Number
Journal	Spak, K.S., Agnes, G.S., & Inman, D.J.	2013	Cable Modeling and Internal Damping Developments	Applied Mechanics Reviews	65,1 DOI:10.1115/1.4023489
Journal	Spak, K.S., Agnes, G.S., & Inman, D.J.	TBD	Bakeout Effects on Dynamic Response of Spaceflight Cables	Journal of Spacecraft and Rockets	SUBMITTED JULY 2013, IN REVIEW